*This presentation is for illustrative and **general** educational purposes only and is not intended to substitute for the official MSHA Investigation Report analysis nor is it intended to provide the sole foundation, if any, for any related enforcement actions.*

GENERAL INFORMATION

Coal Mine Fatal Accident 2004-01

Operator:	Canyon Fuel Company, LLC
Mine:	SUFCO Mine
Accident Date:	January 3, 2004
Classification:	Machinery
Location:	District 9, Salina, UT
Mine Type:	Underground
Employment:	281
Production	28,500 tons/day

ACCIDENT DESCRIPTION

- On Saturday, January 3, 2004, the afternoon shift longwall crew and several other miners traveled to the longwall section to continue freeing longwall shields that were stuck and “iron bound.”
- These shields had become “iron bound” after attempting to mine through setup rooms that had been mined for a possible in-panel longwall move.
- Miners were assigned to work in groups along the longwall face to free various shields.
- A continuous mining machine (CM) section foreman and several other miners worked on No. 49 shield.
- Various methods were tried to free the shield, including cleaning under the base skid.
- None of these attempts or methods succeeded.

ACCIDENT DESCRIPTION

- A longwall shearer operator arrived and offered to assist.
- The shearer operator requested that 2-legged chain slings, customarily used during longwall moves, be brought to the section so that another method of rigging could be attempted.
- The slings were delivered and carried to No. 49 shield.

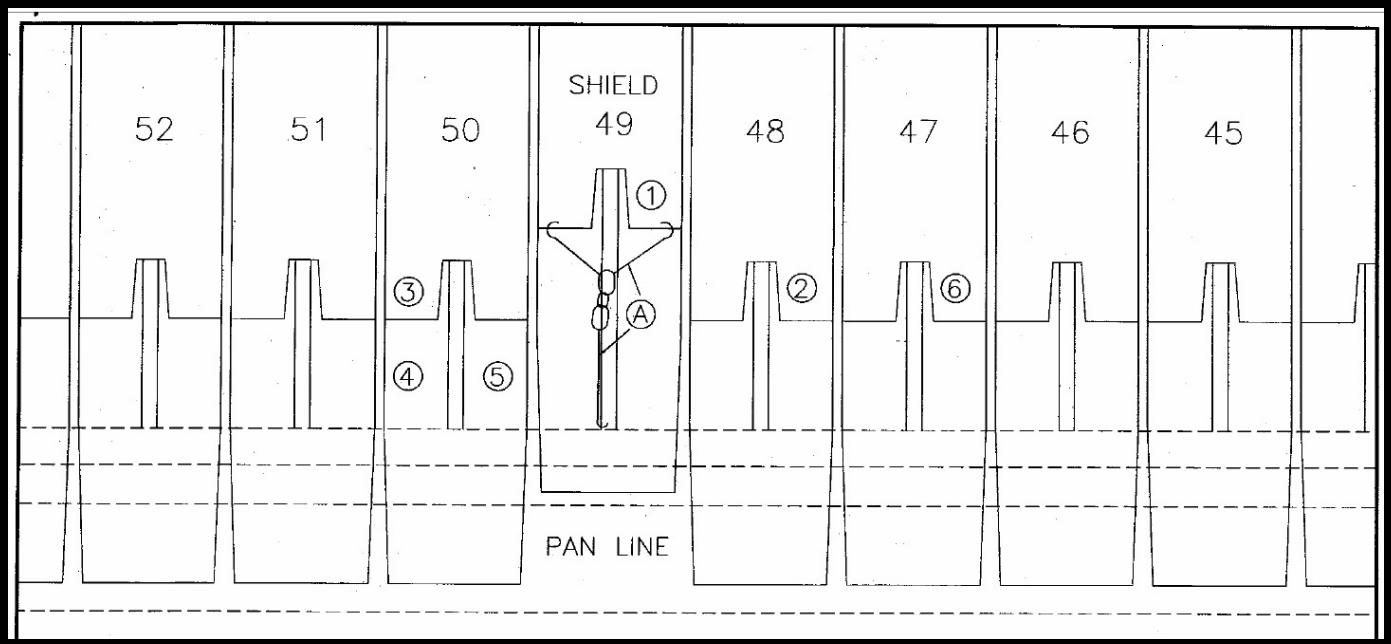
ACCIDENT DESCRIPTION

- Two of the slings were used to connect from the base of No. 49 shield to the face conveyor.
- They planned to tension the sling rigging by pushing the face conveyor forward with the adjacent shields.
- At the same time, the double-acting ram shield advance on No. 49 shield would be used to pull that shield forward. This would also reduce the tension applied to the chain slings as the adjacent shields pushed the face conveyor forward.

ACCIDENT DESCRIPTION

- The shearer operator stood on the base skid of No. 49 shield to operate the manual valves to advance the shield.
- The CM Section Foreman was at No. 48 shield and a diesel mechanic was at No. 50 shield to operate the conveyor advance functions of those shields.
- Several moments passed as the miners attempted to free No. 49 shield using this. Several of the miners heard a “pinging” noise, which they thought was coming from the chain rigging.

ACCIDENT DESCRIPTION



① Shearer Operator (Victim)
② CM Foreman
③ Diesel Mechanic
④ Mechanic
⑤ Laborer
⑥ Longwall Coordinator

Ⓐ Chain rigging between shield & face conveyor

ACCIDENT DESCRIPTION

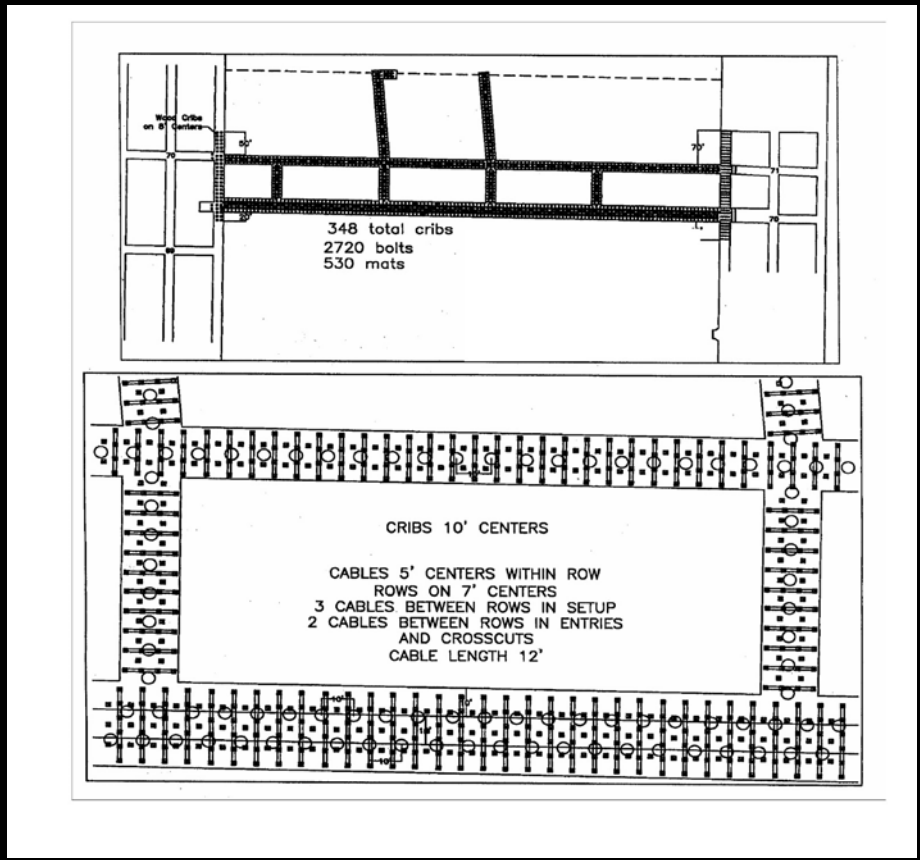
- As the last attempt was made, the hook on the chain sling attached to the face conveyor broke.
- The remaining portion of the hook that was still attached to the chain recoiled, striking the shearer operator in the left side of the face and head, causing fatal injuries.

MINE DESIGN

- The panel was located under a perennial surface stream. During the permitting/leasing process, a plan approved by the Bureau of Land Management (BLM), required a block of coal to be left in place under the stream channel to prevent subsidence.
- This required an in-panel longwall move, so setup rooms were mined outby where the block of coal was to be left.
- However, a revised plan was later approved by BLM allowing mining to continue past the setup rooms.
- An engineering feasibility study was conducted, which determined that with proper additional roof support, the setup rooms could be mined through safely. Mine management decided to mine through the setup rooms rather than make the in-panel longwall move as they determined this to be more economical.

MINE DESIGN

- To mine through the setup rooms, additional support was installed prior to the longwall retreating through the area.



MINE DESIGN

- The longwall retreated through the recovery chutes, inby bleeder entry, and connecting crosscuts with little to no trouble.
- As the longwall entered the setup entry, a significant number of the 4’ diameter cuttable cribs failed prematurely, well below the design strength of 1800 tons, causing convergence of the entry and yielding of the shield supports.
- By January 1, 2004, production ceased due to shields being “iron bound.”
- By January 3, ~24 shields were “iron bound”, and 27 others were deemed “critical”, with less than 6” travel remaining on the legs.

CHAIN SLING

- The toe of the “iron bound” shield was attached to the face conveyor with two similar, 2-legged chain slings. Both slings had the same maximum recommended loads.
- One sling was used as a straight chain, with two chains extending from opposite ends of the master link. One chain was attached to the conveyor pan by placing the hook in the slotted hole used to connect the ram for advancing the longwall. This hole was approximately 2½” x 4⅜”.
- The slotted hole was ~25° from vertical. The angle between the location where the hook was connected to the face conveyor and where the 2 hooks were connected to the toes of the shield was approximately 84° from vertical. The resulting angle between the centerline of the slotted hole and the direction that the chain slings were pulling was ~109°. At this angle, the effective width of the slotted hole for the hook attached to the face conveyor was 2⅝”.

CHAIN SLING

- Each of the components of the chain sling (which broke during the accident) had a recommended maximum working strength of 35,300 lbs, when loaded by a straight pull, with a factor of safety of 4:1 (resulting in a breaking strength of ~141,200 lbs during a straight pull).
- When utilizing both legs of the sling for a pull, the manufacturer recommends a maximum angle of 60° between the two legs of the chain, which provides a working strength of 61,100 lbs and a breaking strength of 244,400 lbs for the sling arrangement.

CHAIN SLING

- The centerline of the hook should have been in line with the centerline of the chain. However, wear marks showed that there was an angle of ~60° between the centerline of the hook and the centerline of the chain.
- This misalignment caused the inside dimension of the hook to spread from approximately 2½" to about 4⅛" before it broke (photo below).
- The hook would not properly engage due to the physical characteristics of the hook and the size and bore of the welded ear on the conveyor, thus causing tip loading of the hook, reducing the working load by 41% (actual working load: 14,473 lbs; actual breaking load: 57,892 lbs).

The force applied by the two adjacent shields during conveyor advance loading to the face conveyor and to the chain sling was 127,840 lbs when the No. 49 shield was not assisting in the process (2.2 x breaking load).

HUMAN FACTORS

- Another sling had failed on the longwall just prior to the fatal accident. This failure was at a different location on the longwall face, involved a different group of miners, and did not cause any injuries.
- The longwall coordinator traveled past No. 49 shield just before the accident and cautioned the miners not to trust the chains. He did not give any directions or instructions on using the chain slings or on the work that was being done.
- The longwall coordinator claimed he did not have authority to direct the workforce or assign duties and only acted in an advisory capacity to mine management on longwall operations.
- Some of the miners, including the CM Foreman, were very uncomfortable with the chain rigging arrangement.
- The victim was comfortable with the chain sling rigging and chose to operate the controls of No. 49 shield.

ROOT CAUSE ANALYSIS

Causal Factor: The failure of the poured-type concrete cribs once the longwall entered the setup entry caused significant convergence of the entry, thus creating tremendous loading on the Joy Mining Machinery 2 x 970 UST supports and causing a yield condition of the supports and subsequent “iron bound” condition.

Corrective Actions: Re-evaluate the mine’s roof control needs in the future and further evaluate the logistics and practice of longwall retreat mining through previously developed entries. In addition, should future use of poured-type concrete cribs be used in a similar situation, testing of the product should be conducted to verify proper mix and that desired strength has been achieved.

ROOT CAUSE ANALYSIS

Causal Factor: Crane's position on No. 49 shield during the process of trying to free the support put him in the direct "line of fire" of the sling rigging in a hazardous location.

Corrective Actions: Additional training was provided for all employees and supervisors about the hazards associated with chain and/or wire rope rigging and safe positioning of persons during rigging processes, especially while these units are tensioned. Management should routinely observe work habits and strictly enforce safe work procedures for proper use of rigging and safe positioning of miners when doing this type of work.

ROOT CAUSE ANALYSIS

Causal Factor: Incorrect rigging and subsequent failure of the two-legged sling between the longwall shield and the face conveyor.

Corrective Actions: Following the January 3, 2004 accident, SUFCO management removed all chain slings from service, used other means to free the “iron bound” shields, and conducted training classes regarding chain slings and the rigging process. SUFCO management should have taken a more proactive approach to the initial sling failure that occurred prior to the accident on the section and made all persons aware of that failure. Both the longwall coordinator and the foreman in charge of the work at No. 49 shield had safety concerns with the chain sling rigging that was being used. Management should strictly enforce safe work procedures for proper use of rigging and safe positioning of miners when doing this type of work. The operator should proactively ensure that proper procedures are followed through job observations, task risk analysis, or equivalent means .

CONCLUSION

The direct cause of the accident was the use of the two-legged chain slings in an application where the applied loads exceeded the design strength of the slings and the improper placement of the hook in the slotted hole on the face conveyor which caused tip loading. The hook was not properly engaged in the elongated slot on the conveyor, and could not be, due to the physical characteristics of the hook and slot. These factors resulted in the hook breaking, recoiling, and causing the accident during the attempt to advance No. 49 shield. In addition, the position of the victim on the toe of No. 49 shield, in the "direct line of fire" of the tensioned chain sling, put him in a hazardous location. The failure of management to take corrective actions when a hazardous work practice was observed was a contributing factor to the cause of the accident.

ENFORCEMENT ACTIONS

103(k) Order was issued on January 4, 2004, to ensure the safety of persons working on the 3 Left Pines East section, MMU001-0, until an investigation of the area and accident site could be completed and the area deemed safe .

BEST PRACTICES

- Ensure that chain assemblies (rigging) are rated for the loads being pulled. Consult the chain manufacturer to determine chain assembly rated capacities and also required de-ratings due to the geometry of the final rigging arrangement.
- Ensure persons are positioned in a safe location before tension is applied when dragging or towing equipment with chains, wire rope, or any other rigging.
- Ensure that chains and hooks are properly attached or rigged.
- Evaluate pillar strength and design before second mining areas containing unusual circumstances, such as setup rooms.